Energy from biomass—
here's where it stands Page 28

MARCH 14, 1983

CHEMICAL & ENGINEERING

NEWS

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MALIGNANT CELLS

Understanding how their genes go awry Page 8

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Cover: Mouse cell after taking up an oncogene. Micrograph courtesy of Mark Furth, Memorial Sloan-Kettering Cancer Center, New York

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NEWS
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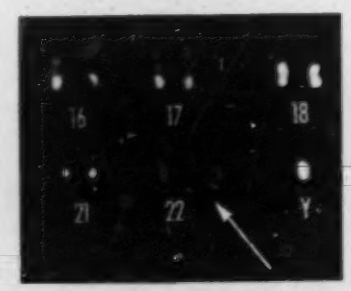

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Chemical Stock Prices Rebound

Chemical stock prices have jumped by nearly half since last summer's low point; despite current low profits, Wall Street is bullish

William J. Storck, C&EN New York

On Wall Street, the current mood seems to be, ignore reality. In fact, pay no attention to earnings. Forget that most forecasters still predict slow recovery for the economy. And don't worry about huge federal budget deficits.

Instead, the stock market continues its startling, record-shattering climb begun last August. For those who view the market as a tried and true leading indicator of the economy, its rapid rise indicates that, poor forecasts to the contrary, the economy is going to be much healthier fairly soon.

For the past few months, the prospect of recovery in the economy, fueled now by falling petroleum prices, has sent the stock market to new heights. The Dow Jones Industrials Average, the most watched stock index, finished the week ending March 4 at yet another high of 1140.96, up 41.3% from a year ago and up 9.2% from the end of 1982.

A number of other factors indicate to Wall Street that better times are ahead. These include falling interest rates, which already have helped housing and automobile industries as well as the capital equipment markets; improvements in both business and consumer confidence; a sharp rise in the government's index of leading economic indicators; and relatively glowing accounts of the current state of the business pickup from private groups such as the National Association of Purchasing Management (C&EN, March 7, page 14).

In other words, the situation is almost the reverse of a year and a half ago, when high interest rates, worries over goverment policies in the money supply, and a general air of pessimism combined to drive stock prices down. For almost a year, the Dow Jones Industrials Average hovered in a range from the high 700s to the high 800s.

From that low point, the stock market idled for a few months and then last summer burst into the upswing that has now taken it to a new historic high.

In spite of the strong performance by the stock market, there is no unanimity on Wall Street about the short-term future of the market. Investors and analysts are divided into two main camps. First, there are those who think that this is a classic bull market and will continue to climb, come what may.

However, there is a strong body of feeling in the financial community that says that the market has been outdoing itself and that there will be a correction soon. This correction, it says, could lower the stock indexes by as much as 10%.

This camp says that the market has ignored what will turn out to be lackluster earnings performance by U.S. companies in at least the first quarter of this year. When earnings reports for the first three months begin to appear, it says, the market may well fall as investors realize that profits typically lag in an economic upturn. That's especially true in chemicals.

However, at present the market is still climbing and chemical stocks have taken full part in the current runup. C&EN's Chemical Stock Index hit bottom in June 1982, about two months before the stock market took off. (C&EN's index is a weighted index based on the stock prices of seven leading chemical companies: Allied Corp., American Cyanamid, Celanese, Dow Chemical, W. R. Grace, Monsanto, and Union Carbide.) Since then chemical stocks have paralleled the general stock market, with a strong upturn after the beginning of the year.

All stock measures are up more than 40% from year ago . . .

	March 4, 1983	March 5, 1982	12-month low	Change from year ago	Change from low
Dow Jones Industrials Average	1140.96	807.36	784.34	41.3%	45.5%
New York Stock Exchange Composite	88.63	63.14	59.69	40.4	48.5
New York Stock Exchange Industrials	101.88	70.43	66.82	44.7	52.5
American Stock Exchange Index	384.82	250.69	237.54	53.5	62.0
Over-the-Counter Composite	265.94	173.97	159.14	52.9	67.1
Over-the-Counter Industrials	319.33	194.76	177.70	64.0	79.7
Standard & Poor's 500	153.67	109.34	103.71	40.5	48.2
Standard & Poor's 400 Industrials	172.23	120.83	115.62	42.5	49.0
C&EN Chemical Stock Index	242	172	163	40.7	48.5

. . . and chemical stocks are near 12-month high

Stock price	March 4	12 month Low	12 month High	% change from low
Allied Corp.	$41 1/4	$28 3/4	$42 1/8	43.5%
American Cyanamid	40 1/2	24 3/8	40 5/8	66.2
Celanese	55 3/8	41 1/4	59 7/8	34.2
Dow Chemical	31 3/4	19 5/8	32 1/4	61.8
W. R. Grace	42 5/8	28 1/2	43 3/8	49.6
Monsanto	90	56 5/8	90	58.9
Union Carbide	61 5/8	40 1/8	62 1/8	53.6

C&EN's Chemical Stock Index has moved up more than 48% to 242 (1954 = 100) as of March 4 from a 12-month low of 163 as of June 18, 1982. Over the past 12 months, the C&EN index has risen 40.7%, just behind the Dow Jones Industrials rise of 41.3%.

In the week ending March 4, 654 stocks on the New York Stock Exchange reached new 12-month highs as opposed to only 14 with new lows. Again, the chemical industry was not left out. Of the seven companies on C&EN's index, five established 12-month highs—Allied, Cyanamid, Dow, Monsanto, and Carbide.

Besides the companies on the C&EN index, a number of other chemical firms set new 12-month highs that week: Air Products, Crompton & Knowles, Ethyl Corp., FMC, B. F. Goodrich, Hercules, International Minerals & Chemical, Loctite, Olin, PPG Industries, Rohm & Haas, and Witco Chemical.

The best performer on C&EN's index in the past year has been American Cyanamid. Cyanamid's stock price has climbed 56.5% to $40.50 from $25.875 a year ago. The rise has been fully 66.2% from Cyanamid's 12-month low of $24.375.

Not far behind, Dow Chemical's stock price has moved up 52.1% to $31.75 from $20.875 a year ago. And if investors had put money into Dow at its low of $19.50, they would have by now a 61.8% paper gain.

In the past 12 months, Monsanto has risen a very respectable 45.2% to $90 from $62 a year ago. And the stock price is up 68.9% from its 12-month low of $56.625.

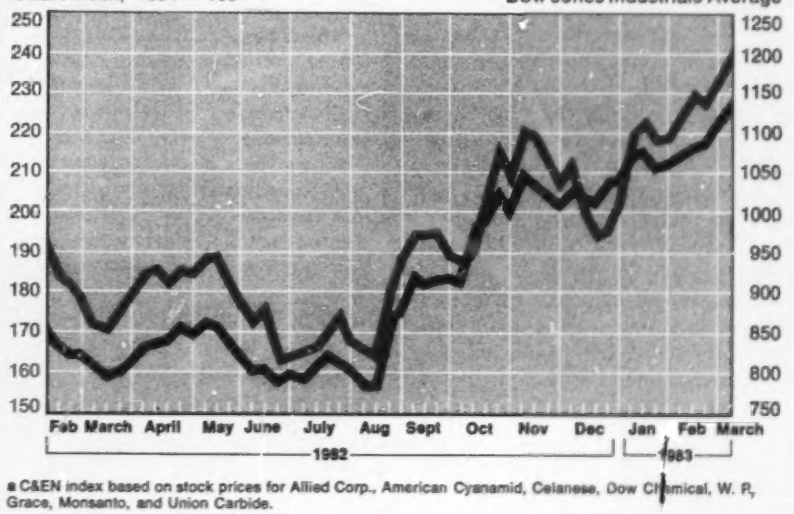
Carbide's stock price in the past year has gone up 41.3% to $61.625 from $43.625. And from its summer low of $40.125, Carbide stock has risen 53.6%.

W. R. Grace has had a 12-month stock rise of 21.4% to $42.625 from $35.125 at this time last year. Its price is now 49.6% above its 12-month low of $28.50.

Allied, which has turned itself into an even more diversified company, has had only a 20.0% increase in stock price to $41.25 from $34.375 at this time in 1982, but it has risen 43.5% from its 12-month low of $28.75.

The lowest performer of the companies on C&EN's index has been Celanese, which showed a big earnings loss in fourth-quarter 1982 resulting in a loss for the year. However, Wall Street has some confidence in Celanese. At $55.375, the Celanese stock price is 5.7% above its year-ago level of $53.375 and 34.2% above its 12-month low of $41.25.

Both Dow Jones and chemical indexes have gained more than 45% from lows



[a] C&EN index based on stock prices for Allied Corp., American Cyanamid, Celanese, Dow Chemical, W. R. Grace, Monsanto, and Union Carbide.

Even with these jumps, chemical stocks and the Dow Jones Industrials trail some of the other well-known stock market indexes. For instance, smaller stocks on other exchanges have performed even better in the current bull market. The Over-the-Counter Industrial Composite has vaulted almost 80% to 319.33 as of March 4 from its low last summer of 177.70. It also has increased 64.0% from its year-ago level of 194.76. The combined Over-the-Counter Composite has risen 67.1% to 265.95 from its low of 159.14 and 52.9% from its year-ago level of 173.97.

The American Exchange Market Value Index has gone up 62.0% to 384.82 from its 12-month low of 237.54 and 53.5% from 250.69 a year ago.

The broader indicators of large company stocks also have done better than have either C&EN's Chemical Stock Index or the Dow Jones Industrials' in recovering from their 12-month lows, but not all are up as much from a year ago. The New York Stock Exchange Industrial Composite increased 52.5% to 101.88 from its low of 66.82 and 44.7% from its year-ago level of 70.43. The combined New York Stock Exchange Composite has gone up 48.5% to 88.63 from its 12-month low of 59.69 but only 40.4% from its year-ago level of 63.14.

The Standard & Poor's 400 Industrial indicator has risen 49.0% to 172.23 from its low of 115.62 and 42.5% from a year ago.

Finally, the overall Standard & Poor's 500 indicator has increased 48.2% to 153.67 from its 12-month low of 103.71 and 40.5% from 109.34 a year ago.

Even with a possible breather on the way, the stock market looks vastly better than a year ago. There are now numerous predictions that the Dow Jones Industrials will top 1200 later this year. Such exuberance on Wall Street, if investors still have their traditional foresight, augers a much better economy this year and next than many business people would believe.

Again, this is the reverse of the opinion polarity a year ago during the economic slide. At that time, many on Wall Street and the stock market itself were predicting renewed recession, whereas most business leaders and government officials were confident of a 1982 recovery. No one would mind now if Wall Street were right. □

Texas' pre-eminence in chemicals is slipping

Probably few people would be surprised to learn that Michigan has lost its place on the list of the top 10 states in the U.S. for chemical manufacturing. After all, not only has Michigan long been ascribed one of the most inhospitable business climates in the nation, everyone knows that heavy industry in general is fleeing the northeast and midwest.

But it might batter a few assumptions to learn that Texas, with its long pre-eminence as a chemical center and friendly business climate, now ranks barely ahead of New Jersey in chemical shipments. Even more surprising would be the revelation that nowhere is chemical activity growing faster than in California, which is popularly considered one of the least advantageous places to do business. Statistics that show these and other trends between 1977 and 1980 have been gleaned from unpublished U.S. Census Bureau data by Inform, a nonprofit research group in New York City.

The most dramatic change from 1977 to 1980 was the weakened status of the Gulf Coast states, despite the general perception of an industrial boom in the Sun Belt. Compared to an industry average growth of 29.4%, chemical activity (measured on the basis of value of shipments minus the costs of materials and energy) increased only 10.7% in Texas and 22.6% in Louisiana. As a result, Texas' chemical activity was only 3.9% higher than New Jersey's in 1980. Louisiana, which ranked fourth in 1977, fell back to sixth in 1980.

In 1977, Texas and Louisiana together accounted for 18.7% of U.S. chemical shipments on a value-added basis. In 1980, on the other hand, the two states made up only 16.5% of that total.

The state with the largest percentage gain was California, where chemical shipments rose 47.8%. In so doing, California moved from seventh to fifth place at a time when its image was seemingly inhospitable to heavy industry. During the same three-year period, Ohio increased its chemical activity 42.2% and rose from fifth to fourth place.

Texas still heads list of top 10 chemical-producing states

Rank	1980 $ millions[a]	1977 $ millions[a]	% change[b]	% of industry total	Rank in 1977
1 Texas	$ 8,090	$ 7,310	10.7%	11.0%	1
2 New Jersey	7,788	6,189	25.8	10.6	2
3 Illinois	4,566	3,507	30.2	6.2	3
4 Ohio	4,562	3,209	42.2	6.2	5
5 California	4,145	2,803	47.8	5.6	7
6 Louisiana	4,017	3,278	22.6	5.5	4
7 New York	3,956	3,121	26.7	5.4	6
8 Pennsylvania	3,470	2,761	25.7	4.7	8
9 Tennessee	2,988	2,276	31.3	4.1	9
10 Indiana	2,456	1,854[c]	32.5	3.4	11
TOTAL	$40,038	$36,308	26.8%	62.7%	
U.S. CHEMICAL INDUSTRY TOTAL	$73,382	$56,721	29.4%	100.0%	

a Totals represent value added by chemical manufacturers (the value of industry shipments minus costs of materials and energy). b Based on value-added totals. c Michigan ranked number 10 in 1977 with a value-added total of $1,676,100.
Source: Inform

The remaining top 10 states increased chemical activity at rates within a few percentage points of the industry's U.S. average. Most stayed where they were in the 1977 ranking, with the notable exception of Indiana, which moved from 11th to 10th place by nudging out Michigan.

Inform notes that the new figures contradict the popular notion that chemical producers are fleeing states with stringent environmental rules. California, which had the sharpest chemical growth, also has the nation's strictest hazardous waste and air pollution control programs. □

New proxy battle embroils GAF

GAF sometimes seems to have its share of hard luck. Not long ago, it went through an entire restructuring, selling off huge portions of unprofitable businesses, only to find itself in a recession that hit its building products operations hard, causing massive losses for the company.

And now, with the recession probably ending and the housing business expected to pick up, the New York City-based maker of building products and chemicals finds itself once more embroiled in a proxy fight.

The latest battle comes from Samuel J. Heyman, who operates a Connecticut real estate business and is a GAF stockholder. Last year Heyman began a proxy fight against the management of GAF, but dropped it when the company's chairman and chief executive officer, Jesse Werner, said that he was negotiating with another company for the acquisition of GAF. Werner also said at the time that there was interest by other companies in acquiring GAF's building products business.

The contest again this year is coming down to a fight between Heyman and Werner. Heyman says that he told Werner that he would drop the proxy fight if Werner would resign and says that he has offered to debate Werner. Heyman tells C&EN that for GAF last year to have advocated the sale of the building products business was "absolutely ill-advised."

Instead, Heyman would like to sell GAF's profitable chemical business to raise cash to pay off the company's long-term debt. However, this would leave GAF as a highly cyclical building products company where the main product has sustained operating losses for the past two years.

In a letter to stockholders, GAF says that Heyman has adversely affected discussions for the sale of the company. It says that two major companies will not enter a stock transaction because they do not want Heyman as a stockholder. The letter also states that GAF will "vigorously oppose" Heyman's attempt to take control of the company. □

Biomass Becoming More Important in U.S. Energy Mix

Projects aimed at developing biomass as an energy source are making good progress in tree culture, gasification, digestion, and liquefaction

Joseph Haggin, C&EN Chicago, and
James H. Krieger, C&EN Washington

The worldwide oil glut may have taken the edge off the thrust toward use of alternative sources of energy. Nevertheless, some energy sources are continuing to grow, particularly the use of biomass.

The amount of energy contributed by biomass and wastes to U.S. energy consumption has now increased to about 2.7 quadrillion Btu (quads), 3.5% of total consumption. It is projected to grow to about 3.5 quads by 1985.

Attention was drawn to that growth early this month, when the Bio-Energy Council released two publications connected with a seminar it conducted in Aspen, Colo., last summer for the Aspen Institute for Humanistic Studies. One publication—"The Increasing Use of Biomass for Energy and Chemicals"—presents the seminar highlights (and is available for $15 from the Bio-Energy Council, 1625 Eye St., N.W., Washington, D.C. 20006). The other publication—"Land Use, Food, Energy and Recreation," by Norman E. Borlaug—is of a public lecture at the seminar (and is available for $6.00).

Speaking at a briefing held to announce the publications and boost the visibility of bio-energy, Philip H. Abelson, editor of *Science* and vice chairman of the board of trustees of the Bio-Energy Council, emphasized the growth in use of biomass. "At a time when oil consumption has been decreasing in the U.S.," he noted, "bio-energy continues to grow at the rate of 50% every five years and today contributes almost as much energy as nuclear or hydro power does."

The Bio-Energy Council is a publicly supported, nonprofit organization created to stimulate industry, government, community, and scientific interests in development of bio-energy.

The council's briefing expands on a more detailed overview presented a month earlier by Donald L. Klass, vice president of the Institute of Gas Technology's education division. He spoke at the Seventh Annual Symposium on Energy from Biomass and Wastes, sponsored by IGT and held at Lake Buena Vista, Fla.

Together, the events underscore the growing importance in the U.S. energy mix of what is a very broad-based energy source. Indeed, the Bio-Energy Council, from an international point of view, tracks progress on nearly 2000 bio-energy activities in more than 60 countries.

Bio-energy encompasses activities ranging from the simple combustion of wood to the gasification of agricultural residues to the recovery of the methane/carbon dioxide biogas from municipal refuse landfills. It involves the development of techniques for improving production of biomass. And it involves the production of fermentation ethanol for blending with gasoline.

Federal support of R&D to develop energy from biomass and wastes continued to decline in 1982. But, Klass notes, much research and commercialization work has continued, and other funding sources are taking up some of the slack.

Gas Research Institute, for example, plans to invest about $75 million from 1982 to 1987 in R&D projects on methane from biomass and wastes. California's State Agricultural & Forestry Residue Utilization Act of 1979 has provided $10 million in state funds and stimulated an additional $36 million in industry commitments for development of bio-

Biomass' contribution to U.S. energy use is growing

Consumption, quadrillion Btu[a]	1975	1980	1981	1985
Petroleum[b]	32.731	34.301	32.122	30.313
Natural gas	19.948	20.495	20.215	17.795
Coal	12.823	15.626	16.109	18.526
Hydro	3.164	2.913	2.721	2.636
Nuclear	1.900	2.704	2.908	4.000
Biomass and wastes	1.750	2.583	2.661	3.467
Geothermal	0.081	0.121	0.138	0.210
Wind	0.082	0.003	0.004	0.012
Solar	0.001	0.011	0.015	0.051
TOTAL	72.400	78.757	76.893	77.010
% Fossil	90.5%	89.4%	89.0%	86.5%
% Nuclear	2.6%	3.4%	3.8%	5.2%
% Renewable	6.9%	7.1%	7.2%	8.3%
% Biomass	2.4%	3.3%	3.5%	4.5%

a Excludes cogeneration and waste heat recovery, purchased electric and steam, and net electric imports. b Includes natural gas plant liquids and liquefied refinery gases. **Source:** Resource & Technology Management Corp.

mass energy projects. These projects are expected to result in net benefits to investors of $300 million during the estimated 20-year life of the projects.

Besides the institutional and state support of U.S. biomass energy activities, investment by private industry also plays a role. Although it isn't known how much this support amounts to, Klass notes, most of the industry support apparently is being made by oil companies.

In the short term, Klass says, wood and wood wastes are projected to continue through 1985 as the major contributions of biomass to primary energy consumption in the U.S. Landfill methane and alcohol fuels are expected to about double in contribution from 1980 to 1985.

One reason for the predominance of wood and wood wastes is their use by the forest products industry for energy. At the Aspen seminar, Weyerhaeuser vice president for R&D John L. Kulp noted that the industry now derives at least 50% of its energy from biomass and in a decade will be obtaining as much as 90% from that source.

According to Klass, growth in energy derived from combustion of wood and wood wastes is expected to continue in industry because wood-fired boiler construction as a percentage of new plant starts has increased steadily since 1977. As recently as 1980, he says, about 50% of all new boiler construction starts, excluding utility boilers, were designed to be fueled primarily with wood.

One of the newest wood-fueled power plants is a 22.4-MW cogeneration plant at Dow Corning in Midland, Mich., that just went on line last November. The plant produces 1250-lb steam (950 °F). Associated with the plant is a nearby 5-acre site where a 30- to 45-day supply of wood fuel for the plant is maintained.

In the effort to develop woody biomass energy, short-rotation intensive culture continues to be one of the main research targets. A Department of Energy program in the U.S. has been under way for five years, establishing field plots and growing trees to the point of first harvest. Jack W. Ranney, field manager of the program, told the Aspen seminar that farming trees for energy has a long-range potential of supplying an amount of wood equivalent to more than twice the total amount of bioenergy being used in the U.S. today.

Biomass energy contribution comes from different sources

U.S. consumption, quadrillion Btu	1979	1980	1981	1982	1983	1984	1985
Wood and wood wastes	1.552	2.299	2.355	2.487	2.618	2.755	2.917
Municipal and industrial solid wastes	0.130	0.187	0.198	0.236	0.288	0.344	0.403
Sewage	0.046	0.054	0.056	0.059	0.062	0.066	0.070
Agricultural wastes	0.023	0.030	0.033	0.035	0.039	0.042	0.046
Alcohol fuels	—	0.009	0.014	0.014	0.015	0.018	0.021
Landfill methane	0.001	0.004	0.005	0.006	0.007	0.008	0.010
TOTAL	**1.752**	**2.583**	**2.661**	**2.837**	**3.029**	**3.233**	**3.468**

Source: Resource & Technology Management Corp.

The DOE program has more than 360 plots involving 40 tree species under evaluation. According to Ranney, the best three-year fields of wood grown on fertile lands without fertilizer have reached 23 to 24 dry metric tons per hectare per year, and poorer, fertilized lands have produced as much as 29 dry metric tons per hectare per year.

Other than direct combustion, gasification, digestion, and liquefaction are the major means of converting biomass to energy and/or chemicals. Klass says that in the case of gasification, a variety of gasifiers, including fixed- and fluid-bed types are being developed. At least 40 suppliers are offering various kinds of gasifiers on the market, but only eight of them have actually sold units, he says. Most of the gasifiers in operation have consumption rates of 1 ton per hour or less.

The largest gasifier in commercial operation is most likely a 100-ton-per-day slagging pyrolysis plant at Disney World. It processes solid waste collected from the Magic Kingdom and nearby communities to produce low-Btu gas for heating water. Completed last October, the unit is still being debugged.

Besides its use as a low-Btu fuel gas, the synthesis gas generated by gasifying biomass can be converted to chemicals. The most likely product from biomass-derived synthesis gas is methanol. Of the processes now under development, Klass believes that the one developed at Battelle's Pacific Northwest Laboratory affords the lowest production costs. At least five types of methanol processes are available, with production costs ranging from 64 to 77 cents per gal. None, so far, are being used for commercial production.

Intense efforts continue to be lavished on gasification by anaerobic digestion to obtain basic knowledge of the microbiology and of new, innovative ways to perform methane fermentation. Klass thinks that one of the most interesting reports in the past year was the recovery of certain thermophilic anaerobes from deep-sea volcanic environments. The anaerobes appear to be capable of producing methane, carbon monoxide, and hydrogen in certain media at 100 °C and atmospheric pressure.

Many research projects are in progress to improve anaerobic digestion, Klass says. For example, there are investigations of genetic methods to develop better strains of methanogenic bacteria, of autohydrolysis to increase the biodegradability of biomass, of the stimulatory effects of selected nutrients on acetate-grown methanogens, and of combined enzymic-chemical treatment to increase the conversion rate of hemicelluloses. And several research approaches to improved digestion performance are ready for scaleup from the laboratory or are being evaluated at the process development unit or pilot plant levels. These, Klass says, include dry fermentation, use of immobilized anaerobes that significantly reduce digestion times, upflow fixed-film digesters for wastewaters, and two-phase digestion in which the

acid and methane formation phases are physically separated.

According to Klass, the number of commercial anaerobic digestion plants in the U.S. increased significantly during the past year, particularly advanced technology systems for industrial wastes. For example, the construction of a novel hybrid anaerobic digestion-rotary kiln in California's Ventura County was announced. The facility will produce 5.4 MW of electricity and 4 million cu ft of gas per day. The kiln will produce steam for turbines, and the wet organic portion of the wastes will produce gas.

Liquefaction of biomass can be direct or indirect. Direct liquefaction includes the natural formation of useful chemicals in plants and seeds as well as production of products by fermentation and rapid pyrolysis. Indirect liquefaction implies the conversion of the biomass to synthesis gas or some other intermediate, which subsequently is converted to the desired products.

Natural liquefaction in plants does provide useful products, but the economics generally are unfavorable compared with petroleum-derived materials. Low oil and fluid yields are the main reasons. The most competitive natural oil with a potential for heating oil production probably is sunflower oil, and it costs about twice as much as conventional diesel fuel from petroleum. The natural oil available in greatest volume is soybean oil. But, Klass points out, the production costs preclude serious attention being given to it as a potential fuel source. The possibilities for direct liquefaction seem to be limited to high-value products that can justify high production costs and extensive purification steps.

Flash pyrolysis appears to be plagued by practical operating difficulties with the pilot plants. Selectivity is poor and the complex products are difficult to separate. Most of the work on flash pyrolysis of biomass is on the bench scale and few projects are still in progress.

For ethanol fuel, the past year was crucial and dramatic, Klass says. Annual sales of ethanol in the U.S. jumped to about 210 million gal from about 74 million gal in 1981. Fermentation capacity for fuel ethanol has been projected for early this year to reach about 526 million gal per year of anhydrous ethanol, with 65 plants of 500,000 gal per year or larger on line.

This capacity is well below the goal of 920 million gal per year by the end of 1982 that was set by DOE's Office of Alcohol Fuels, as specified by Title II of the Energy Security Act. But, as Klass notes, fuel ethanol use and capacity are increasing rapidly.

Several factors account for fuel ethanol's success. First, although the Reagan Administration had intended to eliminate the federal excise tax exemption of 4 cents per gal for gasohol and the federal investment tax credits of 20%, both are still in effect. And indeed, the exemption will increase to 5 cents per gal on April 1 as a result of the new federal gasoline tax and is intended to stay in effect until 1992. Both benefits are expected to give ethanol fuel a new boost.

Another factor is that marketing efforts are phasing out the term gasohol, which had achieved something of a stigma. As an octane enhancer, ethanol holds its own economically. Hence, the new marketing approach simply notes that a given gasoline contains ethanol—or, as one brand points out, it is "fortified" with ethanol.

A third factor in fuel ethanol's success has been the depressed price of corn. This situation, Klass says, has permitted more flexibility and higher profit margins for fuel ethanol producers in the open market. In fact, fermentation ethanol has been competitive with synthetic ethanol recently because of increased ethylene prices and low corn prices. Forecasts suggest that by 1990 fermentation ethanol will be 25 cents per gal cheaper than synthetic.

To keep matters in perspective, Klass points out that alcohol fuel's displacement of gasoline in U.S. markets is minuscule. In 1981, the amount of gasoline displaced by ethanol was about 0.07%. Existing methanol capacity is about an order of magnitude larger than that for ethanol, so its potential to displace gasoline is much greater than that for ethanol. Still, the potential market for alcohol fuels is extremely large.

Methanol has been touted for some time as a logical successor to fermentation ethanol in the long run. However, its fuel use has been hampered by legal restrictions. The Environmental Protection Agency requires that gasoline contain no more than 0.3% by volume of methanol. In recent months, numerous waiver requests to increase the allowable methanol content have been made. Du Pont, for example, has asked to use methanol at concentrations of up to 3%. Late last month, however, EPA decided against the petition, citing the possibility of increased emissions from auto fuel systems as the reason. Indications are that Du Pont, and others, will revive the petition and resubmit it immediately in another attempt to increase allowable methanol content.

Past experience with methanol in fuels has been mixed. Most of the problem appears to emanate from the solvent action of the methanol, particularly in older autos, which have accumulations of resins and tars in the fuel system. Also, there occasionally is a problem with gasket materials. All of these problems may be solved without much difficulty. On the positive side, methanol fuels do appear to provide good fuel values and are considerably cheaper than gasoline.

If the resubmitted petitions to increase the methanol content of gasoline are successful, the prospects for methanol fuels could improve dramatically because of the better profit margins over ethanol. One of the imponderables is the future course of oil prices and, therefore, of gasoline. Most of the methanol is expected to come eventually via syngas derived from biomass and coal. □

Sixty-five fuel ethanol plants were operating in 1982

Plant size, gal per year	Number of operating plants	Total capacity, million gal per year
100,000 to 499,999	14	3.66[a]
500,000 to 999,999	19	13.19
1,000,000 to 2,499,999	14	22.30
2,500,000 to 4,999,999	9	29.98
5,000,000 to 9,999,999	3	21.00
10,000,000 to 49,999,999	1	40.00
50,000,000+	5	340.00
TOTAL	65	470.13

a Includes 2.11 million gal of fermentation capacity for 190- to 192-proof ethanol. Source: Donald L. Klass